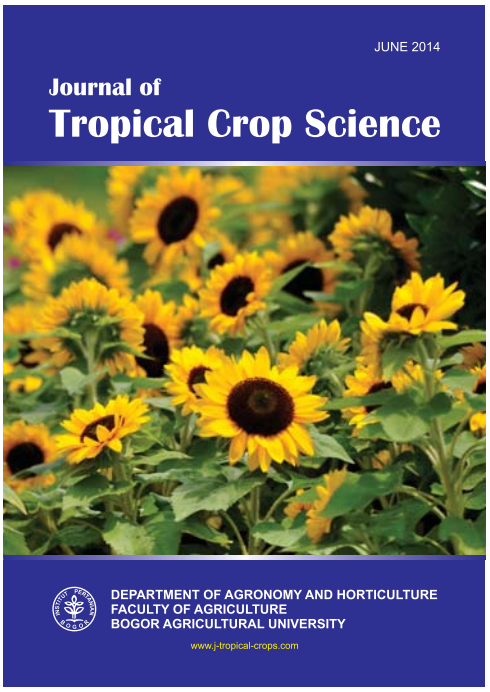

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ON THE COVER

The cover image shows sunflowers by Darda Effendi

SHORT COMMUNICATION

RESEARCH ARTICLES

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Evaluation of Commercial Sunflower (*Helianthus annuus* L.) Cultivars in Bogor, Indonesia for Ornamental and Nursery Production

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Abstract A wide range of imported ornamental sunflower seeds have been marketed in Indonesia. A field evaluation was conducted on seven sunflower cultivars to investigate their germination, growth and development in humid tropical environment in Bogor, West Java, Indonesia and to determine their potential uses. Most of the tested cultivars, except for 'Sungold Double' and 'Velvet Queen', demonstrated good germination and growth. 'Eclipse' was highly susceptible to stem rot, which resulted in only 30% of the plants survived. 'Little Leo', 'Teddy Bear' and 'Sungold Double' were naturally compact, dwarf, and produced attractive blooms so they might be suitable as pot plants. 'Hallo', 'Velvet Queen', 'Sunburst', and 'Eclipse's plant height were more than 100 cm, had long stem and large blooms. These cultivars might be suitable as landscape plants.

Keywords: *morphological characteristics, West Java, pot plants*

Introduction

Sunflower (*Helianthus annuus* Linn., Family Asteraceae) is an annual plant that is known for its large and bright yellow color inflorescences. Sunflower is native to North America (Whipker et al., 1998) and is widely cultivated for their valuable oil, as cut flowers, and ornamental plants. A sunflower is actually a composite of hundreds of tiny flowers clustered together. The disk flowers form the center and normally have both male and female components. The outer layer around the disk is ray florets.

Helianthus has about 67 species (Heiser, 1978) which includes the annuals and the perennials (Anonim, 2005). Sunflower is also commonly used in the landscape for borders or screening (Schoellhor et al., 2004). Commercial cultivars of sunflower are drought tolerant, need full sun, and are capable of growing in a wide range of soil conditions (Schoellhorn et al., 2004).

Introduction of ornamental plants are necessary for diversity in the urban landscape (Suleiman et al, 2009). Imported sunflower seeds, both oil and non-oil, have been marketed in Indonesia. However, limited information is available on the hardiness characteristics of imported ornamental sunflower that were introduced to the warm and wet tropical West Java province. West Java is the most populated province in Indonesia and where most of the urban landscape is growing. Field trial evaluation to assess the performance of the newly introduced cultivars, which is an important component before imported seeds are distributed and marketed, are lacking. Even though sunflowers are known to have wide adaptability to a wide variety of soils and climatic conditions (Warrick, undated) many imported seeds has been reported to have low field establishment rate and low crop productivity and disadvantaged the farmers and growers.

The objectives of this study were to evaluate the seed germination, growth and development of seven imported ornamental sunflower cultivars and to produce recommendations for gardeners and nurseries in Indonesia, particularly in West Java.

Materials and Methods

The experiment was conducted at the Bogor Agricultural University farm at Leuwikopo, Darmaga (6°24'S, 106°33E; elevation 250m) in June to October 2006. The sunflower cultivars 'Little Leo', 'Teddy Bear', 'Sungold Double', 'Hallo', 'Velvet Queen', 'Sunburst' (Mr Fothergill's, England), and 'Eclipse' (Australia) were used. The average temperature ranged from 25-32°C during the dry season (March to August) to 23-28°C during the rainy season (September – February).

Seeds used in this study were obtained from a commercial seed store in Bogor. Seeds were soaked in water for about 30 minutes prior to sowing on trays with pasteurized sand and cocopeat (1:1 by volume) media.

Fifteen-day-old seedlings with a two or three sets of true leaves were transplanted into a 0.5L plastic container with pasteurized soil: coco peat: husk (1:1:1 by volume) media and fertilized with 2g of top-dressed 15N-15P-15K fertilizer. Plants were placed under plastic house and were fertilized weekly with 2 $g.L^{-1}$ 20N-6.5P-12.4K (Gandasil D®; Kalatham Co.) until the plants had first visible bud. Plant spacing was 30 x 30cm. Plants were watered three or four times per week or as needed to keep the media moist.

Data on germination percentage were collected at ten day after seed sowing. Colors of the seed-coat and hypocotyl of each cultivar were recorded. Scoring was

conducted on plant height and stem diameter at the first visible floral buds, the number of inflorescence at anthesis, the number of days from the transplanting date to the first visible floral bud and to anthesis. Number of inflorescence per plant, inflorescence and disk floret diameter were measured at anthesis. Sunflower seeds were harvested at 12 weeks after transplanting, and scoring on 100-seed-weight was conducted after the seeds were dried at room temperature (25°C) for 7 days.

A completely randomized design with 15 single-plant replications was used for this experiment. Data obtained were subjected to analysis of variance using the General Linear Model procedure in Minitab version 15 followed by Duncan Multiple Range Test (DMRT) at 5%.

Results

'Sungold Double' and 'Velvet Queen' seeds had low germination rate, i.e. 36.6 and 40% respectively (Table 1). Other cultivars had germination rate of >60% (Table 1). The main cause of death was stem rot fungal infection caused by *Sclerotium* at the seedling stage.

The height of 'Velvet Queen', 'Sunburst'and 'Eclipse' reached > 2m at anthesis whereas 'Teddy Bear' and 'Little Leo' were < 1m (Table 2).

'Little Leo' had the earliest time (15 days after transplanting) to the first visible floral bud, whereas 'Hallo' had the latest, i.e. 22 days after transplanting (Table 2).

Table 1. Germination rate, seed-coat and hypocotyl color of seven sunflower cultivars.

Cultivar	Germination Rate (%)	Seed-coat Color	Hypocotyl Color
'Little Leo'	60.0	Black	Reddish green
'Teddy Bear'	90.0	Grey	Yellowish green
'Sungold Double'	36.7	Dark Grey	Yellowish green
'Hallo'	70.0	Black	Red
'Velvet Queen'	40.0	Brown	Red
'Sunburst'	66.7	Light Brown	Red
'Eclipse'	70.0	Black	Red

Tabel 2. Plant Height, Stem Diameter and Days to Visible Floral Bud of Seven Sunflower Cultivars *)

Cultivar	Plant Height (cm) at		Days to Visible Floral Bud	Stem Diameter at Visible Floral Bud (mm)
	Visible Floral Bud	Anthesis		
'Little Leo'	30.5d	95.7cd	15.1a	7.3b
'Teddy Bear'	25.7d	75.8d	19.6b	5.9a
'Sungold'	44.1c	127.3bc	20.7bc	6.2a
'Hallo'	80.8a	141.1b	22.3c	7.2b
'Velvet Queen'	67.4b	200.0a	16.6a	7.8b
'Sunburst'	84.7a	204.5a	16.7a	7.2b
'Eclipse'	79.9a	216.4a	21.1bc	7.4b

*) Values followed by different letters within a column are significantly different according to Duncan multiple range test at 5%.

'Eclipse', 'Hallo' and 'Velvet Queen' had the largest inflorescence whereas 'Teddy Bear' had the smallest (Table 3). All cultivars except for 'Teddy Bear' and 'Sungold Double' have both disk and ray flowers.

'Velvet Queen' and 'Hallo' had the greatest number of inflorescence per plant at anthesis (Table 3). 'Velvet Queen' had the greatest 100-seed-weight whereas 'Hallo' had the lowest (Table 3).

All inflorescence except for 'Teddy Bear' and 'Sungold Double's, consist of yellow ray and disk flowers whereas 'Teddy Bear' and 'Sungold Double' have yellow ray flowers only. 'Sunburst' inflorescences were multicolor (Table 4).

Discussion

Seed Germination

All cultivars except for 'Sungold Double' and 'Velvet Queen' had good germination rate of > 60% (Table 1). 'Sungold Double' and 'Velvet Queen' germination rate was 36.6 and 40%, respectively (Table 1). All seeds had similar storage environment prior to planting and no physical damages on the seeds were noted.

The main cause of young plant death was stem rot caused by Sclerotinia infection. The symptoms of the stem rot was determined using a reference on sunflower diseases by Gulya et al. (1993). This fungal has been reported to be a major disease in sunflower worldwide

Tabel 3. Disk Flower and Inflorescence Diameter, Number of Inflorescence/Plant, and 100-Seed Weight [1)]

Cultivar	Diameter (cm)		No of Inflorescence/plant at Anthesis	100 Seed Weight (g)
	Inflorescence	Disk		
'Little Leo'	10.5b	5.0a	9.2c	2.3a
'Teddy Bear'	8.8c	-	8.7c	-
'Sungold'	10.6b	-	12.9b	-
'Hallo'	13.1a	4.5a	15.2a	1.6b
'Velvet Queen'	13.3a	4.9a	16.2a	2.4a
'Sunburst'	9.8b	3.7b	8.3c	2.0ab
'Eclipse'	13.6a	5.6a	8.2c	2.3a

[1)] Values followed by different letters within a column are significantly different according to Duncan multiple range test at 5%;
[2)] 'Teddy Bear'and 'Sungold' did not produce seeds.

Tabel 4. Types and Colours of Sunflower Inflorescence

Cultivar	Inflorescence Types	Color	
		Color	Disk
'Little Leo'	Single	Bright yellow	Green
'Teddy Bear'	Double	Dark yellow	-
'Sungold Double'	Double	Dark yellow	-
'Hallo'	Single	Dark yellow	Black
'Velvet Queen'	Single	Dark red	Black
'Sunburst'	Single	Shades of yellow and pink	Black or dark brown
'Eclipse'	Single	Bright yellow	Black

worldwide (Gulya et al., 1993; Karov et al, 2011) and caused rot in seedlings of a wide range of plants in many agricultural production areas in West Java. First symptoms were observed in the form of leave wilting followed by stem and root rot. A study conducted by Karov et al. (2011) confirmed the presence of ascomycetes *Sclerotinia sclerotiorum* (Lib.) de Bary and *Sclerotinia minor* Jagger in the infected sunflower.

The color of seeds and hypocotyl vary with cultivars (Table 1). The notable cultivar was 'Sunburst' that had red hypocotyl and stem. 'Hallo' also had red hypocotyl but it turned green as the plants get older. Moh (1971) reported the correlation of seed-coat color with hypocotyl color in beans (*Phaseolus vulgaris* L.) and used this correlation as an early screening in plant breeding.

Plant Growth and Development

'Velvet Queen', 'Sunburst'and 'Eclipse' can be classified as tall; their height reached > 2m at anthesis. 'Teddy Bear' and 'Little Leo' were dwarf with the height of < 1m (Table 2). 'Teddy Bear' was the smallest of the seven cultivars tested with a stem diameter of less than 6 mm (Table 2). 'Little Leo' had the earliest time to the first visible floral bud, i.e. 15 days after transplanting or about 30 days after seed sowing whereas 'Hallo' had the latest, i.e. 22 days after transplanting or about 37 days after seed sowing (Table 2).

Inflorescence Characteristics

Number and size of inflorescences vary among cultivars. 'Eclipse', 'Hallo' dan 'Velvet Queen' had the largest inflorescence whereas 'Teddy Bear' had the smallest (Table 3). All cultivars except for 'Teddy Bear' and 'Sungold Double' have both disk and ray flowers.

'Velvet Queen' and 'Halo' had the greatest number of inflorescence per plant at anthesis (Table 3). 'Velvet Queen' had the greatest 100-seed-weight whereas 'Halo' had the lowest (Table 3). All cultivars except for 'Teddy Bear' and 'Sungold Double' formed seeds. Seed weight is one of the important criteria of seed vigor as it indicates the amount of dry matter in the seed (Moshatati and Gharineh, 2012). High seed weight correlated with better seedling establishment and growth (Moshatati and Gharineh, 2012). However, these characters were not included in this study.

The color and shapes of ray and disk flower vary among sunflower cultivars (Table 3). All cultivars except for 'Teddy Bear' and 'Sungold Double' have typical outer ray and disk flowers whereas 'Teddy Bear' and 'Sungold Double' have fluffy and quilted yellow ray-like flowers only.

The color of 'Sunburst' inflorescences varied from pale to bright yellow, and some were bicolor yellow and red (Table 4). These information are important for both growers and landscapers to create floral arrangements or landscape.

'Little Leo', 'Teddy Bear' and 'Sungold Double' plants were dwarf; their height was < 100cm and they had attractive bright bloom colors. Therefore these cultivars would be

suitable as bedding or potted plants, possibly without the need to apply growth retardant that is frequently used for sunflower to obtain short and compact plants (Koutroubas et al 2004, Krisantini et al. 2006). Double flowers look more attractive than single flowers. Therefore 'Teddy Bear'and 'Sungold Double' might also be potential for cut flowers.

'Halo', 'Velvet Queen', 'Sunburst', and 'Eclipse' plants were tall (height > 100cm) and had large inflorescence (Table 2). However, 30% of 'Sunburst' and 'Eclipse' lodged and needed supports at anthesis, likely because the plants were tall and grown in pots rather than on the ground. 'Sunburst' had large variation of bloom colors that were different from the yellow bloom sunflower normally have. 'Sunburst'and Éclipse'are potentials for field-grown landscape plants.

Conclusion

Seed germination of 'Sungold Double' and 'Velvet Queen' in this experiment was poor, i.e. 40% or less so this factor has to be carefully taken into account for commercial production. 'Eclipse' appeared to be most susceptible to sclerotinia; 70% or the seedlings were infected and died at the seedling stage. 'Little Leo', 'Teddy Bear' and 'Sungold Double' were dwarf and have attractive bloom color, hence have potentials as ornamental pot plants. 'Halo', 'Velvet Queen', 'Sunburst', and 'Eclipse' have potentials to be used as landscape plants or cut flowers.

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